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THE ORIGIN AND DEVELOPMENT OF THE
PYCNIDIUM

BY

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY
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THE ORIGIN AND DEVELOPMENT OF THE PYCNIDIUM.

I. Introduction.

The Ascomycetes have been the subject of repeated investigations, especially in regard to the morphology of the perithecium, cytology and sexuality of the ascigerous stage.

The conidial stages placed in the Fungi Imperfecti are of necessity, in the absence of knowledge of their ascigerous stages, classified on a basis of the morphology of the conidia-bearing structures. For this reason, and because the pycnidia are said sometimes to develop directly into perithecia, extension of our knowledge of the morphology of such conidi-iferous structures as the pycnidium and the acervulus, is highly desirable.

The references in literature to the development of the pycnidium are, for the most part, merely incidental; and studies directly devoted to the subject are few. As early as 1876 Bauke (5) described what he considered as three methods of pycnidial development without giving names to them. In 1884, however, DeBary (9) distinguished two main methods of development which he designated as "symphogenous" and "meristogenous": "symphogenous" when the pycnidial primordium arises through the interweaving of young hyphal branches to form a network that is at first loosely woven but later becomes compact and knot-like; "meristogenous" when the primordium arises from a single hyphal cell or a group of adjacent cells of a single hypha by

continued cross and longitudinal division. In the latter, branches from neighboring cells or from the mass itself may share. A number of variations of these two methods have been described. Classification of the pycnidial developments described by Bauke (5) according to the methods distinguished by DeBary (9) places *Cucurbitaria* as meristogenous, *Diplodia* as symphogenous, and *Pleospora polytricha* as a combination of the two.

Zopf (52) in 1890 mentioned three types of pycnidial development: "Hyphenfrucht", "Gewebefrucht," and "Knäuelfrucht." The "Hyphenfrucht" comprises those in which development proceeds from a single hyphal cell which by dividing and swelling forms a quadrant from which with the aid of two or three neighboring cells a primordium is formed. By "Gewebefrucht" is designated those instances in which a tissue mass is formed. This mass may develop in either of two ways: by neighboring cells of a hypha becoming septate, swelling, dividing, becoming more rounded, while short dividing hyphae either from the mass or from neighboring cells of the hypha share in the formation; or in a like manner it may be formed from cells of two or more contiguous hyphae. The "Knäuelfrucht" develops a primordium from one or more short hyphal branches which coil spirally, branch, and interweave into a knot which later develops into the pycnidium. The "Hyphenfrucht" and "Gewebefrucht" are clearly variations of the meristogenous method of development of De Bary. The other, "Knäuelfrucht," is symphogenous.

In addition to the above should be mentioned the "sporopycnidium" of von Tavel (46), referred to also by

Planchon (29) and Schnegg (33). This pycnidium arises meristogenously according to von Tavel, representing the most extreme case of meristogenous development. A single spore in the presence of abundant food germinates and grows a short mycelium; then by division and growth becomes a pycnidium. Reddick (31) notes that pycnosclerotia may be found in *Guignardia*. These bodies arise as pycnidia, produce pycnidiospores, and later function as perithecia, producing asci and ascospores.

Although in many instances the fungi were not studied primarily as to their pycnidial development and such information as was collected regarding this was incidental, according to the figures and descriptions given the following belong to the meristogenous group of De Bary; *Pleospora*, (Gibelli & Griffini, 16; Bauke, 5), *Cucurbitaria*, (Eidam, 14; Bauke, 5), *Pycnis*, (Brefeld, 6), *Fumago*, (Tulasne, 43; Zopf, 53; Schostakowitsch, 34), *Sphaeronaema*, (Halsted & Fairchild, 18), *Pycnidium* with *Teichospora*, (Nichols, 27), *Phyllosticta* with *Alternaria*, (Planchon, 29), *Sphaeropsis* and *Coniothyrium*, (Potebnia, 30), *Chaetophoma*, (Arnaud, 3), *Phoma*, (Reddick, 31; Mercer, 26; Schnegg, 33). *Endothia*, (Anderson, 1). As symphogenous may be classed: *Cincinnatiobolus*, (DeBary, 8), *Fumago*, (Tulasne, 43; Zopf, 52), *Diplodia*, (Bauke, 5; van der Bijl, 44), *Graphiola*, (Fischer, 15), *Cystispora*, (von Tavel, 46), *Hendersonia*, (Voges, 45; Wolf, 51), *Pycnidium* with *Sphaerella*, (Higgins, 21), *Sphaeropsis*, (Hesler, 19), *Septoria*, (Levin, 25). A few of the species have both types of development.

The present investigation is aimed to extend our knowledge of the very early stages in the development of the pycnidium and kindred structures.

II. Methods.

For the present study, the fungi were either isolated from their hosts or cultures were procured from various sources as noted. Corn meal agar (35) was used because it gave an abundant growth and its transparency facilitated the study of even the youngest stages. Other media were used in a few instances for comparison. Cultures for study were grown in petri dishes, at room temperatures (15° - 37°C.) Transfers were made by lifting hyphae or spores from pure cultures to the poured agar in petri dishes. Drop cultures of melted agar were made by the use of sterile pipettes. In some cases the drop of agar was inoculated with spores as for dilution plating. In others, each drop was inoculated by transfer. These drop cultures served well for study of early stages of development, but seldom produced mature conidiiferous structures.

Disks of agar containing young pycnidia were removed from petri dish cultures, placed on cover glasses, and inverted on van Tieghem rings in order to follow further the development of the pycnidia. Growth in petri dishes was observed periodically, the intervals depending upon the rate of growth of the organism. Pycnidia of each species were kept under observation during their entire period of early development. For close detailed study and for drawing, mounts were made by removing from petri dish cultures small squares of agar containing pycnidia in various stages of development, mounting them either

in water for immediate study, or in glycerine for later study. Material from test tube cultures was teased out and studied for comparison and verification of many points.

Following the usage of earlier writers, DeBary (9) Bauke (5) Zopf (52) and von Tavel (46), the word primordium is used throughout this thesis to designate a group of cells that have become so differentiated that it is clearly evident that from them a pycnidial or similar structure will arise.

III. Genera and Species Studied.

PHOMA (Fries) Desmazières.

Phoma herbarum West; isolated from its host, Polygonum hydropiper L. at Urbana, Ill., July 8, 1916.

Pycnidia are produced in cultures in moderate abundance. All stages of development from the mature pycnidia on older mycelium to beginning stages on the younger mycelium can be observed even in a small sector of a petri dish culture. Development proceeds typically from a single cell of a hypha. This cell divides both transversely and diagonally (Fig. 12) into a few cells which swell and enlarge. These cells by continued swelling and dividing form an irregular mass with very few or no hyphal branches. This mass shows distinctly its origin from a single hypha (Figs. 12, 13, 14). As the mass continues to enlarge, one side protrudes slightly as a short rostrum which becomes lighter in color (Fig. 15). This is the primordium which later becomes a pear-shaped pycnidium with an ostiole from which spores are discharged, (Fig. 16). The development is a typically simple meristogenous one.

Phoma pirina (Fries) Cooke; isolated at Urbana, Illinois May 10, 1916, from dead twigs of Pyrus communis L. from Savoy, Illinois.

This fungus produces abundant small pycnidia 60 to 120 μ in diameter, at first closed but later with an ostiole 20-30 μ wide. The spores vary in size from 5 x 3 to 10 x 4 μ .

A few cells of the hypha swell, divide both crosswise and diagonally, swell, and divide again, (Figs. 17,18). This small mass continues to enlarge by cell division, a few hyphal branches bud out from it (Fig. 19). By continued development an irregular mass (Fig. 20) is formed which is the primordium of the pycnidium. In a few cases closely lying hyphae may take part in the formation (Figs. 21,22,23,24), but the typical method of development is the simple meristogenous one from a few cells of a single hypha.

Phoma destructiva Plowr.; isolated at Urbana from fruits of tomato (Lycopersicon esculentum Mill.) in September, 1915. In all respects the disease and the fungus agreed with the one described by Miss Jamieson (22).

The pycnidial primordium usually arises meristogenously. In most cases a single hypha gives rise to the primordium, (Figs. 25,26,27,28), in other cases two or more hyphae share in its formation (Figs. 29,30,33). In either case adjacent cells swell, divide crosswise and diagonally until a rounded or elongated mass is formed, slightly darker in color than the mycelium. The former, (Fig. 26) is the simple type of meristogenous development.

Phoma. species indet.; isolated from stems of clover (Trifolium pratense L.) at Urbana, Illinois, in July, 1916.

Development takes place in a simple meristogenous manner. One hypha only is involved in the formation of the primordium, (Figs. 34-38). Short hyphal threads sometimes branch from the mass. The cells are usually large and swell into a rounded shape. The mass develops more rapidly at one end than at the other so that the young pycnidium is slightly conical.

Phoma species indet. of the Concord variety of grape (Vitis labrusca L.), isolated from a berry from a vineyard near Collinsville, Illinois, September, 1917.

A portion of the culture viewed under the high power of the microscope showed a very characteristic arrangement of hyphae and of pycnidia in various stages of development. (Figs. 39-44). The simple meristogenous development of the primordium is similar to that described for Phoma herbarum West. (Figs. 12-16).

Phoma cichorii Passr.; isolated from Phlox divaricata L. by Mrs. Esther Young True, at Urbana, Illinois, November, 1917.

A few adjacent cells of a single hypha or of a number of contiguous hyphal strands divide into short cells, (Figs. 45, 46). By budding and swelling, short hyphal branches arise, the cells of which swell and divide, (Fig. 47). The cells of the mother strand or strands also enlarge and divide. The component hyphae anastomose, forming a pseudo-parenchymous irregularly-rounded mass. This mass develops into the pycnidium. The development of this fungus differs from that described for the other species in that, where only a single strand is involved, the mode is simple meristogenous with the original cells and their budding branches anastomosing to form the mass, (Fig. 47).

In instances where two or more strands are involved, (Fig. 48) there has been a similar division, swelling, and branching in each strand, but the whole has been united into a single primordium as described for Phoma destructiva, (Fig. 33). This mode is compound meristogenous.

Macrophoma (Sacc.) Berl. & Vogl.

Macrophoma citrulli (B. & C.) Berl. & Vogl.; isolated by Dr. J. A. Elliott from a canteloupe (Cucumis melo L.) leaf procured from Alabama in the autumn of 1915.

Young pycnidia and small sclerotia form in abundance, soon rendering the culture dark brown or black. Usually a single cell in a hypha becomes slightly swollen. It then divides into two short cells, (Fig. 49). These cells in turn divide by cross, longitudinal and diagonal walls, (Figs. 50, 51). The swelling continues until the body becomes a rounded or oblong mass much darker than the light brown mycelium, (Figs. 57, 58). The cells immediately adjacent to the dividing mass may divide into short cells and send out hyphal branches, (Figs. 53, 54, 55). The outer cells of the mass may also send out branching hyphae. The hyphae from all these sources form a net work about the enlarging mass. Sometimes the hyphal branches fuse with the mass and in other cases they appear to have no part in its formation. The body thus developed is the primordium from which the pycnidium arises. It continues to enlarge, becomes pear-shaped, forms an ostiole and develops spores. This mode of development is meristogenous with a slight modification in that short hyphal branches either fuse with or form an envelope about the primordium.

Less frequently a second method appears, in which short branches from main mycelial strands direct themselves toward a point. There these branches interweave, swell and divide to form a net work, (Fig. 59). This net work is at other times formed by the looping back or snarling of hyphal branches. The tangle enlarges, becomes more tightly woven, then the cells divide, swell, and anastomose to form a pseudo-parenchymous mass, (Fig. 60). This method is symphogenous. This species gives rise to both meristogenous and symphogenous developments.

The pycnidia of the species studied in the genera *Phoma* and *Macrophoma* indicate that both meristogenous and symphogenous methods of development may be found. These species present in the main the simple meristogenous mode in which a few cells of a single hypha take part, (Figs. 12,17,26,34,40,49,55). Also a slight variation of the simple development in which hyphal branches both from the dividing cells and from other cells of the mother hypha form a network about the original cells taking part in the development, (Figs. 47,50,58). The compound meristogenous development is that in which two or more main hyphae lying parallel or crossing begin to divide into short cells at a point of contact, swelling and dividing to form a primordium (Figs. 29,33,48). A few adjacent cells of each hypha and some surrounding branches take part in this type of development.

Sphaeronaema Fries.

Sphaeronaema fimbriatum (E. & H.) Sacc. procured from Dr. Byron D. Halsted, October, 1916.

Halsted and Fairchild (18) report and figure the development of the pycnidium of *Ceratocystis fimbriata* as follows:

"In its initial stages the pycnidium arises as the swollen and curled or twisted tip of a vegetative hypha, or as a twist or knot in a sporophore between the conidium and its point of union with the main hypha. Although observed to be present in numerous cases, no anastomosing of different hyphae branches seems necessary. Almost simultaneously with the first curving of the hypha tip, side branches arise which, by their growth and formation of septa, form the coarsely cellular membranous wall of the pycnidium."

Single mountings from plate cultures gave all stages of development verifying the above description. The usual development was the twisting, budding, branching and enlarging by cell division of single twisted hyphal branches, (Figs. 61, 62, 63). This is a variation of the meristogenous development.

Sphaeropsis Léveillé

Sphaeropsis malorum Pk. This fungus was isolated from apple fruits (*Pyrus malus* L.) from Centerville, Indiana, in October, 1916.

Hesler (19) gives the development of the pycnidium of *Physalospora cydoniae* Arnaud in agar cultures as follows, "The dense pseudo-parenchyma of the maturer fruit bodies suggests meristematic divisions, but apparently the structure, for the most part, arises symphogenetically.

"In agar cultures a group of threads may be observed to be directed toward a common point where the pycnidium is to be formed. Here the hyphae are composed of cells from 6 to 7 μ broad, their length varying from 20 to 70 μ , always longer than broad. In the region where the pycnidium is to be developed,

the cells become noticeably shorter by the laying down of new walls; the cells also increase in diameter by growth, and the hyphae increase their numbers by branching. The interspaces found in the earlier stages are filled by the growing in of these branches and by a budding-like action of the hyphal cells bordering the space."

Among my own notes upon Sphaeropsis malorum Pk. made prior to the appearance of the above is a description of the development of the primordium which it seems worth while to give here.

The pycnidial primordium of this species is formed usually according to the method designated by DeBary as symphogenous. A number of hyphal branches interweave near their ends, (Fig. 64). These in turn branch and the branches also interweave. (Figs. 65,66). The central portion becomes a tightly woven mass. The whole continues to enlarge until a spherical mass is formed, which develops into a pycnidium. Most of these primordia form deeply embedded in the agar, though a few develop on or near the surface. Those developing embedded in the agar are smooth, while those on the surface have a fuzzy appearance. A very few pycnidia form by the compound meristogenous method previously described for *Phoma*. These usually form from two or more contiguous hyphae in which a few adjacent cells divide, swell, continue to divide and enlarge until a primordium similar to the one previously described is formed.

Sphaeropsis citricola McAlpine; isolated at Urbana, Illinois, January, 1916, from a kumquat fruit (Fortunella margarita Swingle) from Lake City, Florida. The condition produced on the

rind of the fruit was that of a very black carbonaceous spotting which finally spread over the whole fruit.

In culture a coarse brown mycelium 5-8 mu in diameter is produced. Numerous pycnidia 80 to 175 mu in diameter develop from primordia each of which arises either from a single cell or a few adjacent cells in a single hypha. This cell or group of cells (Figs. 67,68) divides by cross and diagonal walls, (Figs. 69,70,71,72) later by the addition of longitudinal walls to form a rounded or elongated mass (Figs. 73,74) which is slightly darker in color than the mycelium. This mass becomes globose, light brown, carbonaceous and reticulated, and is the primordium. Development is usually simple meristogenous. The compound meristogenous mode is seldom found, (Figs. 75,76,77). From pycnidia developing from these masses small hyaline spores 5-7 x 4-5 mu exude.

The genus *Sphaeropsis* presents a variation of the symphogenous development in that the branches interweave near their ends at a point some distance from the main mycelial strands, (Fig.64). It also shows the more usual symphogenous type (Figs. 65,66) described for *Macrophoma*, (Figs. 59,60). Simple meristogenous development occurs in one species. The compound mode seldom occurs in the species studied.

Coniothyrium Corda.

Coniothyrium pyriana (Sacc.) Shel. A pure culture of this fungus was isolated from twigs of apple (*Pyrus malus* L.) from Savoy, Illinois, October, 1916.

A few adjoining cells of a main hypha become slightly swollen and divide into short cells, (Figs. 78,79). These cells

swell, divide by cross, diagonal and longitudinal divisions, continue to swell and send out short hyphal branches by budding, (Figs. 80,81). This body increases in size becoming darker in color. Branches from adjoining cells or closely lying hyphae may interweave with the branches from the mass at length forming a primordium, (Fig. 82) from which a pycnidium develops. Usually this primordium arises from a single main hypha, but occasionally two or more contiguous hyphae are included in its formation. The mode of development is meristogenous with small hyphal branches being at times included in the formation. Both simple and compound modes are found, but the compound mode seldom occurs.

Coniothyrium species indet. A culture of this organism was procured from the air of the laboratory in the summer of 1917 by W. S. Beach.

A few adjacent cells in a single hypha divide into shorter cells. These cells branch profusely, (Fig. 83). A few of the cells continue to divide and swell, the branching hyphae divide and branch, (Fig. 84). The whole becomes a more closely formed mass, (Fig. 85) which forms a globose, dark brown, finely reticulated primordium. From this the pycnidium develops. The mode of development is simple meristogenous.

The genus Coniothyrium so far as studied presents only the meristogenous development.

Septoria Fries.

Septoria polygonorum Desm. This fungus was isolated from its host Polygonum persicaria L. at Urbana, Illinois, July, 1916.

The development of the primordium is in most cases by the usual meristogenous method but in some instances it is atypical. Some of the primordia arise from a single hypha, one or two cells of which divide transversely and diagonally, and swelling slightly, continue to divide, (Fig. 86). Later this mass develops into a globose, finely reticulated, pale brown, colored body. In some instances the compound mode appears in which two or more hyphae are involved in the formation, (Fig. 87). In other cases primordia are to be found arising from a main hyphal strand with numerous branches of near-by hyphae intermingling in the mass, (Fig. 88). This involves both the meristogenous and the symphogenous methods so may be considered a combination of the two. The principal method of development is meristogenous.

Septoria scrophulariae Pk.; isolated from its host Scrophularia leperella Bicknell by Mr. Walter S. Beach during the summer of 1917.

In pure culture it produces a closed sporing body, the primordium of which arises either from a few cells of a single hypha or from two or three closely lying hyphae, (Figs. 89, 90). These primordial cells divide, swell and continue to divide to form a small ball-like structure which later develops into one or more pycnidia. They thus arise either by the simple or compound meristogenous mode.

Septoria helianthi E. & K.. This organism was isolated from its host Helianthus grosseserratus Martens by Mr. Walter S. Beach in the summer of 1917 at Urbana, Ill. Pycnidia form readily in culture. A single cell or a few adjoining cells in

a hypha become slightly swollen. These then divide into shorter cells which swell and send out very short branches, (Fig. 91). The swelling continues until a rounded mass is formed slightly darker in color than the pale brown mycelium, (Fig. 92). The body thus formed becomes almost globose in shape. The outer portion or covering becomes membranous with a cellular appearance. This primordium continues to enlarge, and becomes ovate or elliptical in shape. The development is simple meristogenous, within a single strand of mycelium.

The genus *Septoria* can hardly be judged by these few species, but these with those reported in the literature indicate that the two main methods of development, namely meristogenous and symphogenous and even a combination of these two, may occur.

Sphaeronaemella Karst.

Sphaeronaemella fragariae Stevens & Peterson. This fungus was procured from Dr. Alvah Peterson, Urbana, Illinois. A few cells of a single hypha divide producing very short cells. These bud and branch profusely, usually in one direction, into short hyphae, (Fig. 93). These branches anastomose, (Fig. 94) twining about in a circular manner. They then divide and swell, forming a small mass which usually protrudes from one side of the main mycelial strand from which it arises, (Fig. 6). The body thus formed is the primordium from which the pycnidium arises.

In the genus *Sphaeronaemella* a striking variation of the meristogenous development is found in that a few cells of a main mycelial thread begin to divide as in the simple meristogenous mode, but short hyphal branches arise from these, usually

on one side, curling and twisting about each other to form a ball-like mass. In some cases this mass envelops and includes the main hypha. (Fig. 95).

Gloeosporium Desmazières & Montaigne.

Gloeosporium rufomaculans (Berk.) Thüm. This fungus was isolated from fruit of apple (*Pyrus malus* L.) from Neoga, Illinois, September, 1917.

The primordium of the acervulus arises from a number of neighboring hyphae. These branch into short hyphae which branch in turn forming a loosely woven network. A spreading tuft arises from this loosely woven base (Fig. 98). This cushion with its tuft of short hyphae is the primordium. It usually originates symphogenously, sometimes meristogenously.

Gloeosporium musarum C. & M. This fungus was isolated from a banana (*Musa sapientum* L.) from the Champaign market, July 28, 1916.

Short hyphal branches from main mycelial strands interweave near their ends. Other hyphae intertwine about this initial portion. Some branches fold or loop back upon themselves while still others branch again. The cells of the interwoven mass divide, swell and branch, (Fig. 99). At length a cushion-like base is formed. This is the primordium of the acervulus from which short conidiophores arise which bear conidia. In terms of pycnidial development it arises symphogenously.

In culture this fungus bears many spores either sessile or upon short conidiophores outside of acervuli, scattered freely upon the mycelium. These spores appear before

the formation of acervuli, making the study of the beginning of acervuli difficult.

Colletotrichum Corda.

Colletotrichum lagenarium (Pers.) E. & H. This fungus was isolated from a watermelon (*Citrullus vulgaris* Schrad.) procured on the Champaign market, September, 1917.

The primordia of the acervuli begin their formation deeply embedded in the media, even near the bottom, by the time the culture is four centimeters in diameter and no more than four or five days old. At this age no conidia have developed upon the short conidiophores or as buds from cells of hyphae as often occurs when the culture becomes older. The primordia arise by two methods. First, from a few cells of a main hypha arise a few or many short bud-like hyphae (Figs. 100,101,102,103). These elongate, intertwine and branch to form a cushion-like base from which very short conidiophores arise. In the second method, hyphal branches from a few neighboring or contiguous mycelial strands intertwine, some of the threads forming short loops which mass, intertwine and branch, (Figs. 104,105,106,107) forming an irregularly shaped, loosely made, cushion-like base from which conidiophores arise as in the other type. Irregular (~~shaped~~) large acervuli, or acervuli-like groups, bearing numerous conidia arise in this latter type. The first mentioned type may be considered as meristogenous, both simple and compound modes appearing. The second is symphogenous.

The genera *Gloeosporium* and *Colletotrichum* have been extensively studied by Shear (36) Stoneman (42), Southworth (38,39) Edgerton (11) and others. Late stages of development and cross sections of different stages have been figured from fixed material in host tissues but little has been said in regard to the early development of the acervulus. The three species studied give insight only into the origin of the cushion-like base from which the acervulus arises. They present two distinct types the simple loosely woven base that arises from a single hypha or from a few contiguous hyphae and the more complexly interwoven base which arises symphogenously.

Pestalozzia de Notaris.

Pestalozzia palmarum Cke. The pure culture of this fungus was procured from the Centralstelle für Pilzkulturen, Amsterdam, Holland.

A few hyphae, usually from two to six, lying side by side form a bed in which a few cells begin to divide into shorter cells. These cells may be in only one of the hyphae, (Fig. 108a) or they may be contiguous cells of two or more hyphae, (Fig. 111). These cells swell, continue to divide by cross and longitudinal walls at length forming a protruding oval or obovate body, (Fig. 108b) which is the primordium of the pycnidium-like body which later forms. This primordium arises by either simple, (Fig. 108a) or compound meristogenous, (Fig. 111) development. It soon becomes globose and membranous with a cellular outer wall but remains light of color so that a few dark spores may be seen within, (Figs. 109,110). At this

stage the structure is to all appearances a young pycnidium, (Fig. 112). Within a few days the top breaks, the few spores already formed are extruded, sometimes rather forcibly, (Fig. 113) and the cavity then becomes saucer-shaped. Conidiophores arise in profusion and many spores are produced. When the first spores are noted the body is a pycnidium, if observed in a latter stage it appears like an acervulus. In Pestalozzia capiomanti similar facts were noted by Bainier & Sartory (4), Leininger (24) in his studies of P. palmarum speaks of these bodies as pseudo-pycnidia.

Pestalozzia guepini Desm. This fungus was isolated from the fruit of a kumquat (Fortunella margarita Swingle) from Lake City, Florida, January, 1916.

A few pycnidia were produced in plate culture. In the beginning stages a number of branches of closely lying or nearby hyphae branch, snarl and intertwine, (Figs. 114, 115). Cells within the more closely twined part of the mass swell, divide by continued cross and longitudinal divisions until a rounded mass is formed which is the primordium of the pycnidium, (Fig. 116). This primordium arises symphogenously. The development of the final sporing body from this stage is very similar to that described for Pestalozzia palmarum.

Pestalozzia species indet. This organism was isolated by the author November, 1916, from leaves of peony (Paeonia officinalis Retz) procured by Dr. H. A. Anderson near Crawfordsville, Indiana.

A good growth of mycelium and numerous sporing bodies were produced in plate cultures. The mycelial threads are

slightly larger than those of other Pestalozzias studied.

Pycnidial primordia arise usually by the compound meristogenous method, (Figs. 118,119). As these bodies develop from the pycnidial stage to the open type, the formation of spores within, (Fig. 120) a breaking open of the pycnidium and its further development into what appears to be an acervulus may be seen.

Pestalozzia. species indet. A pure culture of this fungus was procured from Dr. G. P. Clinton, New Haven, Conn. in November, 1916. It had been isolated from dead maple (Acer) bark in October, 1910.

This Pestalozzia was the most vigorous of all those cultured. Sporing bodies were produced in abundance.

Two or three contiguous hyphae, or, in some cases, as many as ten or twelve take part in the formation of the primordium. A few cells continue to swell and divide until a small mass is formed (Fig. 121). They branch slightly, (Fig. 122) until a primordium of tissue-like type is formed. It is of compound meristogenous development especially pronounced in cases where ten or more hyphae take part. The young pycnidia-like bodies continue to develop, produce spores, then break open, (Fig. 123) and change into the acervulus form as in the previous species mentioned.

In Pestalozzia a condition is found to exist that is quite distinct from any other acervulus forming fungus studied in that it first produces a sporing body which morphologically is a pycnidium. These pycnidia arise by any of the various modes previously described.

The different species vary in the manner of development but whatever the method of development there first appears

a pycnidium which later breaks open and becomes acervulus-like.

Patellina Speg.

Patellina fragariae Stevens & Peterson. Pure cultures of this fungus were procured of Dr. A. Peterson, September, 1916. It was also isolated from strawberries, (*Fragaria chiloensis* Duschesne) from Centerville, Indiana, June, 1916. This fungus forms numerous sporodochia in concentric rings in plate cultures.

These sporodochia arise in two rather typical ways. A few cells of a hypha divide into very short cells. These cells swell and bud producing numerous branches in some cases, (Fig. 126) in other cases a tuft of two or three branches. These branches elongate slightly to form a pedicel, (Fig. 127) then branch at the tips and radiate to form a distinct urn-like body (Fig. 128) within which a cushion or bed forms and gives rise to the conidiophores. The sporodochia are usually produced singly by a simple meristogenous mode. In other instances sporogenous areas develop and in these one or two cells, in each of the closely lying hyphae, branch profusely, (Fig. 124). Numerous of these branches unite into a mass and without the formation of a definite pedicel and peridium, (Fig. 125) give rise to hundreds of conidiophores.

Patellina, species indet. This organism was isolated from a quince (*Cydonia vulgaris* L.) procured on the Champaign market, November, 1917.

Strands of from six to twenty hyphae are formed and at some definite point within the strand a few adjacent cells branch. Thus a tuft of a number of branches is formed, (Fig.

129). This tuft becomes slightly larger at the upper end by continued branching while the lower portion constitutes a pedicel consisting of a few large branches in those cases where a few hyphae enter into its formation. A more substantial closely formed pedicel or base is present if a larger number of hyphal branches are concerned in its origin, (Figs. 129, 130).

The upper half or less becomes cup-like and the outer hyphae curve inward as a superficial covering while within conidiophores and conidia are formed. The type of development is compound meristogenous.

In the genus *Patellina* the sporodochium develops in a very characteristic manner arising by the meristogenous method. A single isolated mycelial thread gives rise to a very simple sporodochium. If a number of mycelial strands are crowded together each branches characteristically and the branches form a sporodochium of the compound type. The type of sporodochium varies with the type of base formed.

Volutella Tode.

Volutella fructi S. & H. This fungus was procured from Mr. Wilmer G. Stover, of Ohio State University. It was isolated by G. C. Meckstroth in the winter of 1916 from a fruit of apple (*Pyrus malus* L.) grown in Western Ohio.

The sporodochia form in abundance in plate cultures the primordium arising from a main hypha. A definite portion, one, two, or three cells in length, takes on a brownish color. These cells divide and some of them branch, usually from one

side only, (Figs. 131,135) forming a small tuft (Figs. 131,136) the branches of which elongate and then divide again forming a larger tuft. (Figs. 132,133). The first interwoven branches form a short pedicel. This cup-like structure may be regarded as the primordium of the sporodochium (Fig. 134) from which a bed of short conidiophores is formed. The development is clearly simple meristogenous. Other larger bases are quite often formed symphogenously. Then hyphal branches from all nearby mycelial threads interweave and anastomose forming a black mass of sclerotial character from which hyphae arise and interweave into a cup-like bed from which conidiophores develop.

Volutella circinans (Berk.) Stevens & True, isolated from a white globe onion (Allium cepa L.) at Urbana, Illinois, September, 1917.

Promordia arise by either of two methods; simple meristogenous (Fig. 137) or symphogenous. (Figs. 139,140,141). In most instances a black stroma-like mass of interwoven hyphae is formed symphogenously, (Figs. 141,142). The sporodochium later develops from this. Setae may be found arising as hyphal branches, (Fig. 138).

Volutella is very similar to Colletotrichum and Gloeosporium in the origin of the sporing bodies; the two methods meristogenous and symphogenous are found. The principal distinction is in the formation of a more compact and usually larger base or subicle upon which the sporodochium is produced. The origin of this subicle if it is simple is usually meristogenous but if a complex subicle is formed it arises symphogenously by the interweaving of numerous hyphal branches.

Epicoccum Link.

Epicoccum, species indet. This fungus was isolated from a plate culture in which it appeared as a contamination in October, 1917.

The sporing body of this fungus arises from two or more closely lying hyphae which produce erect branches from a rather localized area. Two or more such hyphae arise which branch in turn near their tips. These form a spreading tuft of conidio-phores each bearing a conidium at its end. This is a simple form of sporodochium, (Fig. 143). The development is compound meristogenous.

The Pycnidial Stage of Meliola (?) camelliae (Catt.) Sacc.

This pycnidium was studied from herbarium material collected by Dr. F. L. Stevens in Porto Rico. The fungus which usually is reported as M. camelliae and is perhaps better known as "Sooty Mold" (48) is plainly not a true Meliola as the genus is limited by recent writers (17,40) and the position of its ascigerous stage has not been definitely determined.

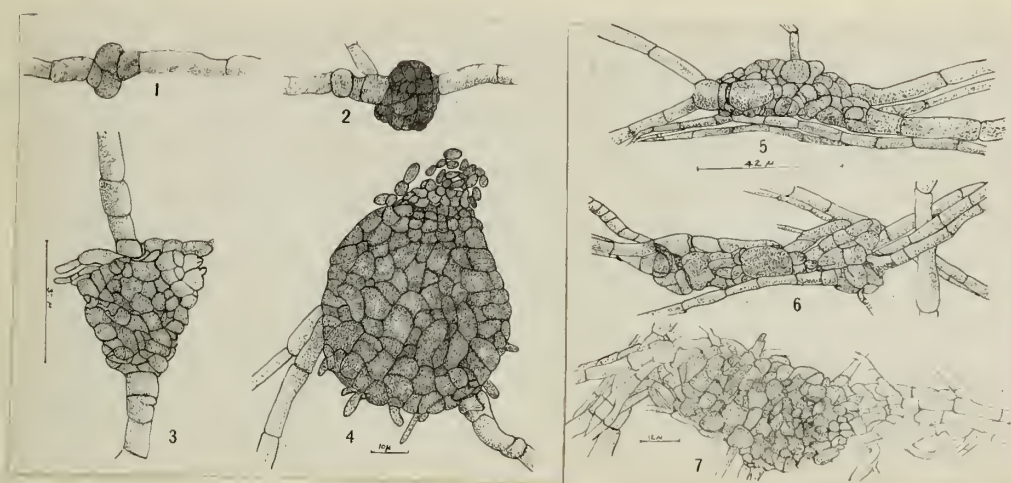
A small pycnidium arises from a single cell of the main hypha or a single cell of a hyphal branch. The initial cell is usually an intermediate cell but it may be a terminal cell. In either case it divides by transverse and diagonal walls into two, then four cells, (Fig. 144) and by swelling and dividing becomes an elliptical, finely reticulated, dark brown body (Figs. 145,148,146,147). The mode is simple meristogenous.

These observations do not essentially disagree with the descriptions as given by Zopf (53) and Tulasne (43) who studied early stages of the development of the pycnidium of

the Sooty Molds.

IV. Discussion.

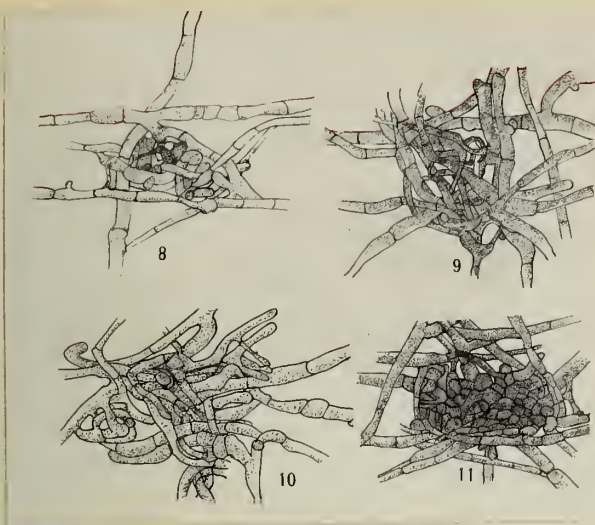
Two main methods of origin and early development are found in pycnidial formation, namely meristogenous and symphogenous. The meristogenous method resolves itself into two modes, simple, (Figs. 1,2,3,4,) and compound (Figs. 5,6,7). In the simple mode the pycnidium develops from a single cell or a few



Figs. 1-7, see text.

adjacent cells of a single hypha. In the compound mode adjacent cells of two or more contiguous hyphae divide, swell, and sometimes branch, all of these then anastomosing freely to form a pseudo-parenchymatous mass. Variations of these two modes are found in Macrophoma citrulli, (Figs. 50,54,58), Coniothyrium pyriana, (Figs. 80,81,82), Septoria polygonorum, (Figs. 87,88), Sphaeronaema fimbriatum, (Figs. 61,62,63) and Sphaeronaemella fragariae, (Figs. 93-96).

The symphogenous method (Figs. 8-11) is less often found in the species studied. In this method of development, branching hyphae from main mycelial threads are directed toward



Figs.8-11, see text.

a common point, loop back and interweave to form a loose network which later becomes more close. The hyphae of this ball anastomose into a pseudo-parenchymous mass from which the pycnidium develops.

Table I.

	Simple Meristogen- ous	Compound Meristogen- ous	Symphogen- ous
<i>Phoma herbarum</i> West.	#	-	-
<i>Phoma destructiva</i> Flowr.	#	#	-
<i>Phoma pirina</i> (Fries) Cooke	#	-	-
<i>Phoma</i> from clover	#	-	-
<i>Phoma</i> from grape	#	-	-
<i>Phoma cichorii</i> Passr.	#	#	-
<i>Macrophoma citrulli</i> (B. & C.) Berl. & Vogl.	#	#	#
<i>Sphaeronaema fimbriatum</i> (E.&H.) Sacc.	#	-	-
<i>Sphaeropsis malorum</i> Pk.	-	#	#
<i>Sphaeropsis citricola</i> McAlpine	#	#	-
<i>Coniothyrium pyriana</i> (Sacc.) Shel.	#	#	-
<i>Coniothyrium</i> species indet.	#	-	-
<i>Septoria polygonorum</i> Desm.	#	#	#
<i>Septoria scrophulariae</i> Pk.	#	#	-
<i>Septoria helianthi</i> E. & K.	#	-	-
<i>Sphaeronaemella fragariae</i> S. & P.	#	-	-
<i>Pycnidium</i> of <i>Meliola</i> (?) <i>camelliae</i> (Catt.) Sacc.	#	-	-

Table I gives the species and the methods of development found in each of the pycnidium forming species. *Phoma herbarum*, *Phoma pirina*, *Phoma* from clover, *Phoma* from grape, *Sphaeronaema fimbriatum*, *Coniothyrium* species indet., *Septoria helianthi*,

Sphaeronaemella fragariae and a pycnidium of Meliola (?) camelliae show a simple meristogenous origin and development and other methods of development seldom or never appear in these species.

In Phoma destructiva, Phoma cichorii, Sphaeropsis citricola, Coniothyrium pyriana, and Septoria scrophulariae the pycnidial primordia arise by either the simple or compound meristogenous modes, the simple mode being the more common.

Macrophoma citrulli, Sphaeropsis malorum, and Septoria polygonorum give rise to their pycnidial primordia by either the symphogenous or meristogenous methods. In Sphaeropsis malorum the symphogenous method is the main one. The compound meristogenous method appears occasionally. In Macrophoma citrulli the simple meristogenous mode prevails but the others are often found. In Septoria polygonorum the compound meristogenous mode is more often found though a few primordia arise by the symphogenous method and occasionally the simple meristogenous mode appears.

Variations of these three modes of development are found. No two species give exactly the same development. In symphogenous development a few branches from nearby hyphal strands may interweave near their ends or intermingling hyphae may loop back, branch and interweave or snarl into a knot-like mass. In the simple meristogenous mode the origin may be a single cell which swells and divides or a number of cells that swell and divide simultaneously. In some cases branches arising from the dividing cells, anastomose with the enlarging mass. In other cases branches arise from more distant cells of the same strand and take part in the development. In a few instances short

bud-like branches arise from a few cells of a hyphal strand, enlarge, divide into short cells, intertwine and anastomose to form a pycnidium.

Neither the acervuli-forming fungi in the Melanconiales have been studied as to the early development of their sporing bodies nor has the origin of the sporodochium been given special attention. Sherbakoff (37) in studies of *Fusaria* describes a simple type of sporodocium found in cultures. Tulasne (43), Stoneman (42), Southworth (38,39, Wolf (50,51) and others figure and describe later stages of the development of acervuli and the later development of sporodochia are referred to in the literature but the subject is considered merely incidentally.

The fungi that form acervuli and sporodochia may be classed according to the manner of origin and development of the primordia on the same basis as the pycnidia-forming species.

Table II.

	Simple Meristogen- ous	Compound Meristog- enous	Symphogen- ous
<i>Gloeosporium rufomaculans</i> (Berk.) Thüm.	-	-	#
<i>Gloeosporium musarum</i> C. & M.	-	-	#
<i>Colletotrichum lagenarium</i> (Pers.) E. & H.	#	#	#
<i>Pestalozzia palmarum</i> Cke.	#	#	-
<i>Pestalozzia guepini</i> Desm.	-	-	#
<i>Pestalozzia</i> from peony	#	#	-
<i>Pestalozzia</i> from maple	-	#	-
<i>Patellina fragariae</i> S. & P.	#	#	-
<i>Patellina</i> from quince	-	#	-
<i>Volutella fructi</i> S. & H.	#	-	#
<i>Volutella circinans</i> (Berk.) S. & T.	#	-	#
<i>Epicoccum</i> species indet.	-	#	-

In Table II fungi of the Melanconiales and Tuberculariaceae that were studied are listed indicating the method or methods

of development of the primordia. In Gloeosporium rufomaculans, Gloeosporium musarum, and Pestalozzia guepini the primordia originate by the symphogenous method. In Colletotrichum lagenarium and Volutella circinans the symphogenous method prevails though the simple meristogenous mode occurs occasionally. The compound meristogenous mode is well exemplified by Pestalozzia palmarum, Pestalozzia from peony and from maple. Epicoccum, and Pestalozzia from maple have only the compound meristogenous mode. The simple meristogenous method of development appears in Colletotrichum lagenarium, Pestalozzia palmarum, Pestalozzia from peony, Volutella fructi and Volutella circinans; it also is at times observed in the development of isolated sporodochia of Patellina fragariae. This mode is more seldom found than either the compound meristogenous or symphogenous method in the development of acervuli and sporodochia.

The Pestalozzias studied present a type of sporing structure which is in need of further investigation in other genera and species. From the mature structure it has been classed as an acervulus, but from its origin and development it is not a true acervulus for it arises as a pycnidium and opens to form an acervulus when mature. This may be called a pseudo-acervulus.

According to Potebnia (30) and Diedicke (10) some Septorias and Ascochyas have open topped sporing bodies that arise by the interweaving of hyphae to form a bed from which arises a peridium partially surrounding the inner sporing surface. Such a structure is very aptly designated by Potebnia (30) as a pseudo-pycnidium.

Study of the origin and development of the sporing bodies of the many genera and species of the Sphaeropsidales and Melanconiales which have not yet been investigated will no doubt add to these two types.

In the pycnidia-bearing fungi studied the meristogenous method of development is the more prevalent with the symphogenous type seldom appearing. In species forming acervuli and sporodochia so far as studied the tendency is toward the more complex methods especially if *Pestalozzia* be regarded as belonging to the Sphaeropsidales. As was to be expected in the pycnidial development no sexual organs, ascogenous hyphae or nuclear fusions were observed.

Summary.

1. Pycnidia originate and develop by two main methods, namely meristogenous and symphogenous, (Figs. 1-11).
2. The meristogenous method resolves itself into two modes, simple, (Figs. 1-4) and compound, (Figs. 5-7).
3. Variations of the meristogenous method are found, e. g. in Coniothyrium pyriana (Figs. 78-82) and Sphaeronaemella fragariae, (Figs. 93-96).
4. The symphogenous method (Figs. 8-11) is less often found and is variable (Figs. 59,64).
5. Acervuli arise in the same manner as do pycnidia, simple acervuli by the simple meristogenous mode (Figs. 97,100,101, 102,103; 108-110); complex ones usually by the compound meristogenous (Figs. 121-123) or symphogenous method (Figs. 98,99;104-107).

6. Complex subicles usually arise symphogenously (Fig. 142) though they may arise by the compound meristogenous mode.
7. Simple sporodochia, especially those appearing on single isolated strands, originate by the simple meristogenous method (Figs. 126-128; 131-135).
8. Complex sporodochia, with a large base or subicle usually arise either by the compound meristogenous mode (Figs. 124-125; 129-130) or symphogenously (Figs. 139-142).
9. The pseudo-acervulus of the species of *Pestalozzia* studied arises and develops as a pycnidium which breaks open and appears like an acervulus (Figs. 103-113; 118-120; 121-123).
10. The simple meristogenous development is the more often found in the Sphaeropsidales while the compound meristogenous and symphogenous modes are the more usual in the Melanconiales and Tuberculariaceae.

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Band 40: Nr. 7, 1878. Also separate of same.

Explanation of Plates

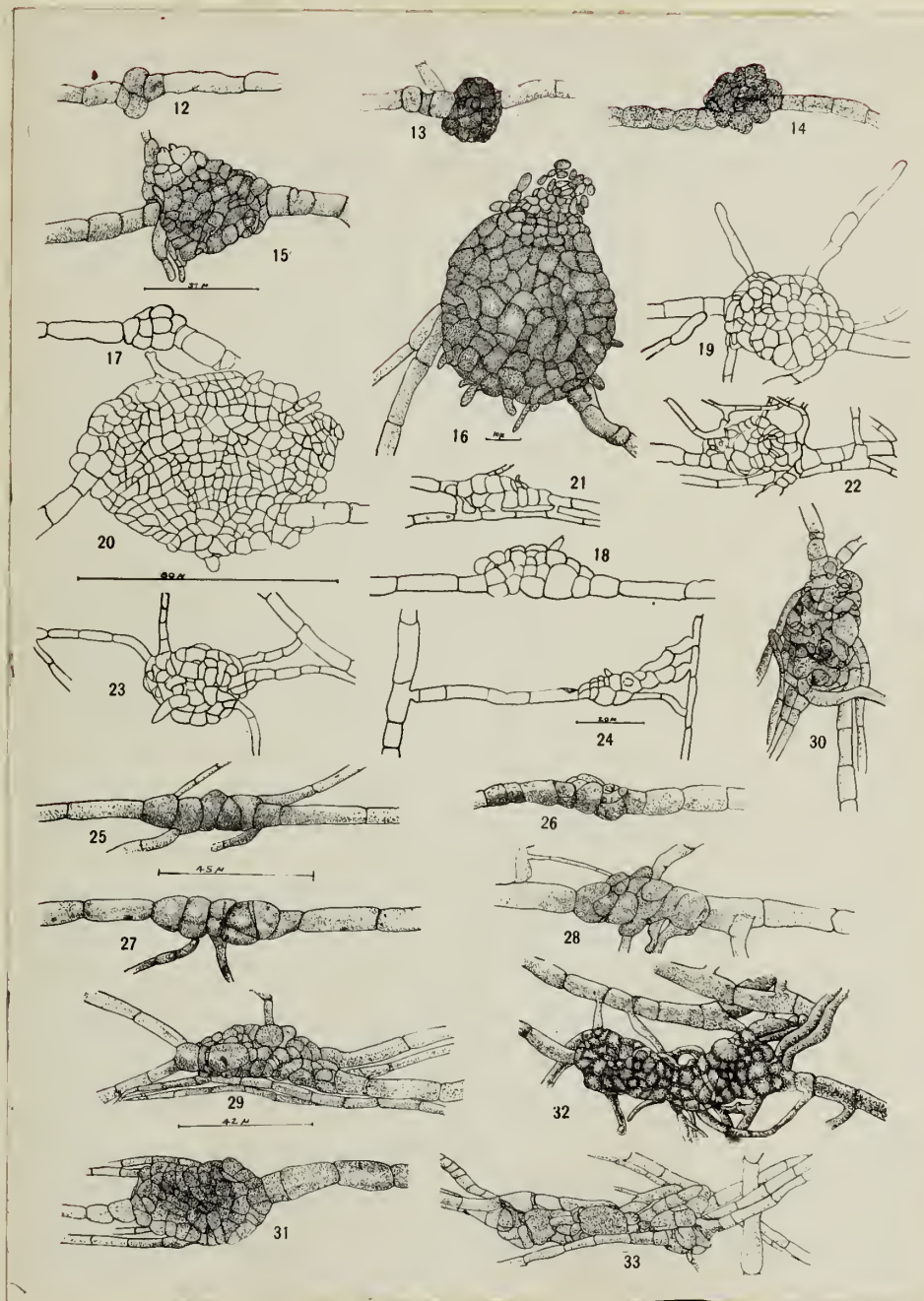
The drawings were made with a Leitz camera lucida and a Leitz one-twelfth oil immersion lens or a number six objective. The scale appears on the plates. Figures 1 to 11 inclusive are inserted as text figures.

Plate I.

Phoma

- Fig. 12. P. herbarum West. Four celled stage of pycnidial primordium of simple meristogenous origin.
- Fig. 13. A slightly later state.
- Fig. 14. Stage similar to fig. 13.
- Fig. 15. Young pycnidium with light colored rostrum where ostiole will form.
- Fig. 16. Mature pycnidium and spores formed by simple meristogenous development.
- Fig. 17. P. pirina (Fries) Cooke. Few celled stage. Simple meristogenous origin.
- Fig. 18. Slightly later stage.
- Fig. 19. Many celled pseudo-parenchymous stage with branches protruding from the mass.
- Fig. 20. Irregular mass from which pycnidium develops.
- Figs. 21, 22. Few celled stages in the origin of which two or more hyphae are involved. This is compound meristogenous origin.
- Fig. 23. Similar to 22, but slightly older.
- Fig. 24. Primordium in which a three parted hyphal strand is involved.
- Figs. 25, 26, 27. P. destructiva Plowr. Beginning stages in pycnidial development. Simple meristogenous origin.
- Fig. 28. Slightly later stage.
- Figs. 29, 30. Compound meristogenous development in which two or more hyphae are involved.
- Fig. 31. Development near the end of a hypha with branches budding from the mass.
- Fig. 32. An irregular meristogenous development.
- Fig. 33. A typical compound meristogenous development with three parallel hyphae involved.

PLATE 1



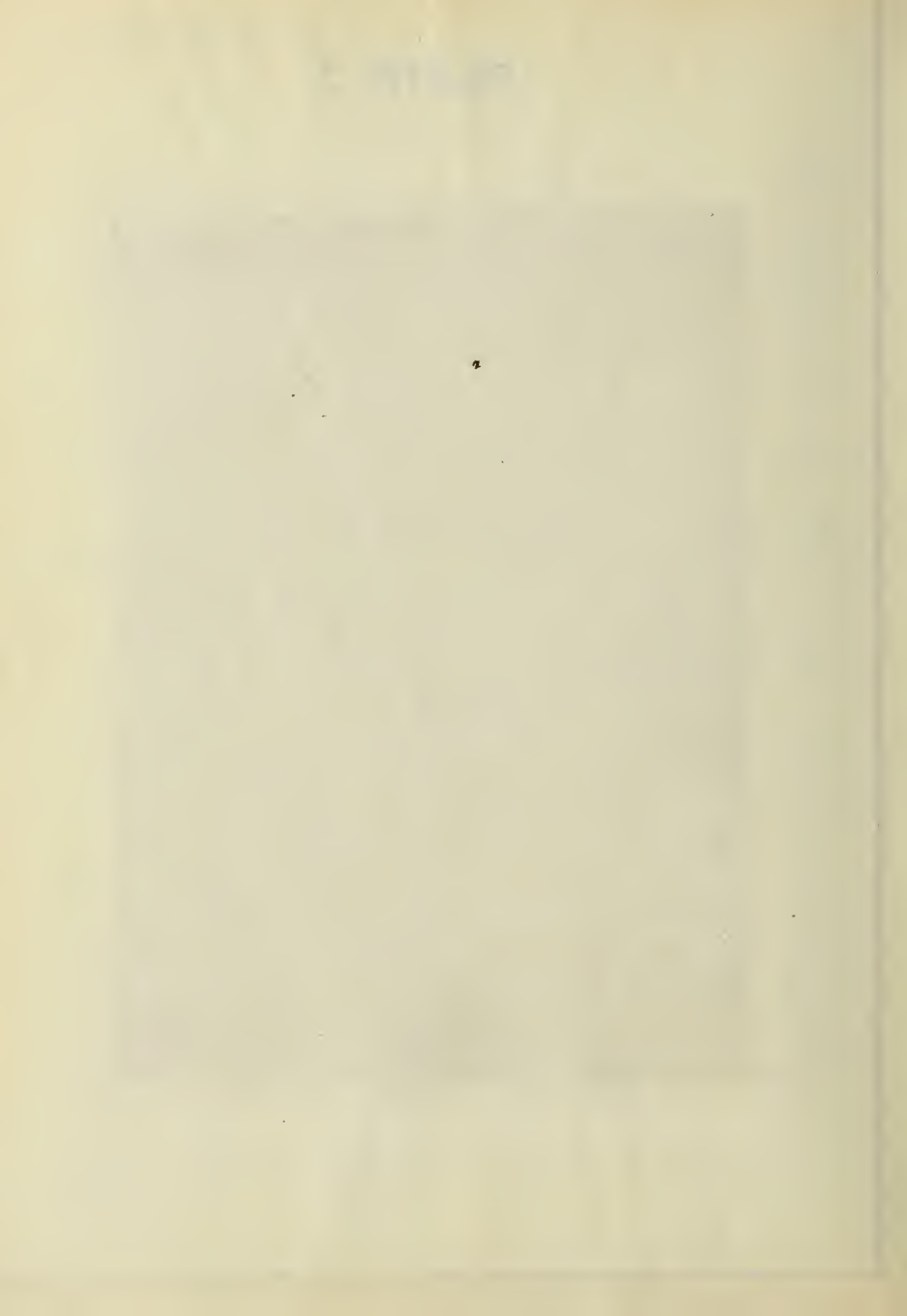


Plate II.

- Figs. 34,35. Phoma from clover. Beginnings of pycnidia.
- Fig. 36. Slightly older stage with a few short, budding branches.
- Figs. 37,38. Later stages with one end enlarging slightly.
- Fig. 39. Phoma from grape. View, under high power, mycelial threads with different stages of pycnidial development.
- Fig. 40. Beginning stage. Simple meristogenous.
- Figs. 41,42,43. Later stages.
- Fig. 44. Mature pycnidium.
- Fig. 45. P. cichorii ^{Passr.} An early stage in the development. Short cells are formed which divide and branch.
- Fig. 46. An early stage in which there is much branching.
- Fig. 47. A medium stage in simple meristogenous development.
- Fig. 48. A typical compound meristogenous development.

Macrophoma

- Fig. 49. M. citrulli (B. & C.) Berl. & Vogl. Two celled stage in the origin of the pycnidium, from drop culture. Simple meristogenous development.
- Fig. 50. The same twelve hours later.
- Figs. 51, 52. Early stages of other pycnidia, from drop culture. Slight variation from simple meristogenous type in that many branches are involved.
- Figs. 53,54. Early stages in which much branching takes place. Drop culture.
- Figs. 55,56. Early stages from petri dish culture.
- Figs. 57,58. Later stages.

PLATE 2

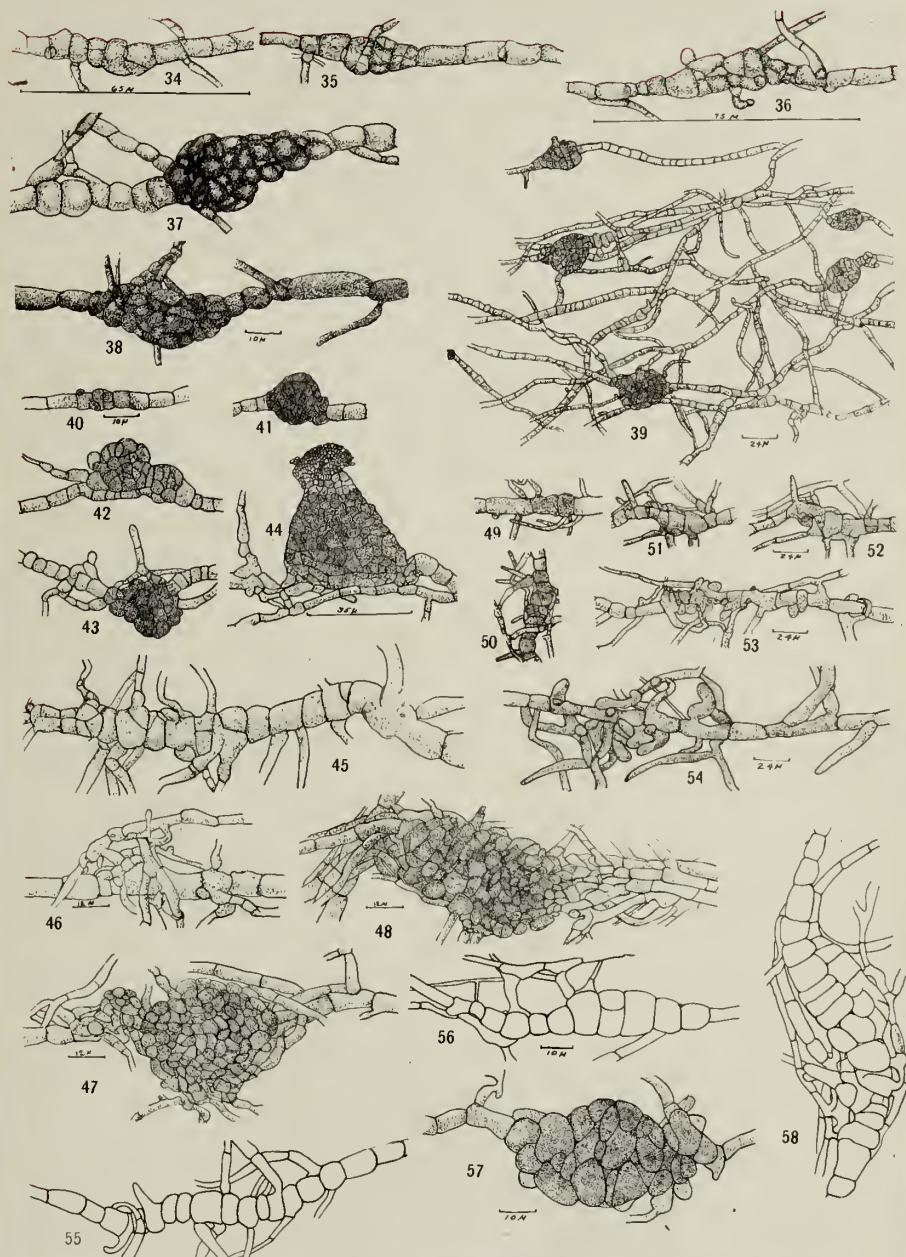


Plate III.

- Fig. 59. M. citrulli (B. & C.) Berl. & Vogl. Symphogenous development in which branches from a number of main strands interweave.
- Fig. 60. A later stage in which a winding of the hyphae and cell division has taken place forming a pseudo-parenchymous mass.

Sphaeronaema

- Figs. 61,62,63. S. fimbriatum (E. & H.) Sacc. Early stages of the pycnidium in which a hypha coils, branches and divides to form a knot-like mass.

Sphaeropsis

- Fig. 64. S. malorum Pk. An early stage in the symphogenous development in which branches a,b,c, interweave near their ends to form a ball.
- Fig. 65. Interwoven hyphae in early stage of a symphogenous development.
- Fig. 66. A slightly later stage.
- Figs. 67,68. S. citricola McAlp. Very early stages in the origin of the simple meristogenous development of pycnidia.
- Figs. 69,70. Slightly later stages.
- Figs. 71,72,73,74. Later stages with short hyphae branching from the masses.
- Figs. 75,76,77. Unusual examples of developments in which more than one hypha is involved. The mode is compound meristogenous.

Coniothyrium

- Figs. 78,79. C. pyriana (Sacc.) Shel. Early stages in the development.
- Figs. 80,81. Later stages in which numerous branches from the dividing mass are involved.
- Fig. 82. Pseudo-parenchymous mass from which a pycnidium arises.

PLATE 3

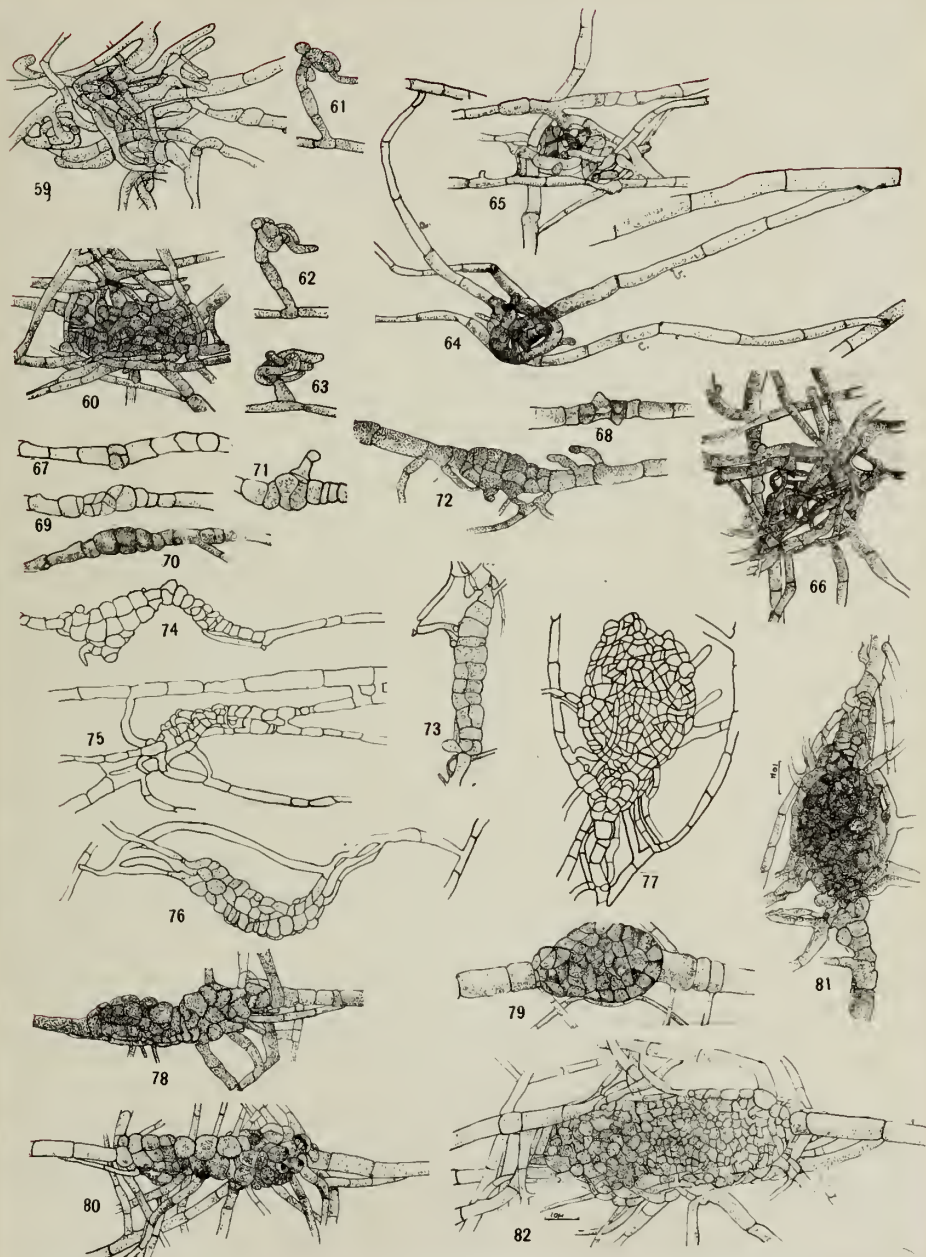


Plate IV.

- Fig. 83. Coniothyrium species from laboratory air. Early stage showing short cells and short branches as origin.
- Fig. 84. Slightly later stage in which cells and branches from main hypha divide into short cells and anastomose.
- Fig. 85. Stage slightly more developed than fig. 84. A slight variation from the simple meristogenous type is shown here.

Septoria

- Fig. 86. S. polygonorum Desm. Beginning stage of the simple meristogenous development.
- Fig. 87. Development in which the original hypha and numerous branches are involved.
- Fig. 88. Pseudo-parenchymous primordial mass formed by the symphogenous method.
- Figs. 89, 90. S. scrophulariae Pk. Early stages in the compound meristogenous development.
- Fig. 91. S. helianthi E. & K. Early stage in the beginning of the simple meristogenous development.
- Fig. 92. A later stage.

Sphaeronaemella

- Fig. 93. S. fragariae S. & P. Early stage of simple meristogenous development.
- Fig. 94. A later stage in which branches and original hypha have anastomosed to form a mass on one side of the main strand.
- Fig. 95. A later stage in which the mass surrounds the main strand.
- Fig. 96. A late stage which has developed by a winding and dividing of the hyphal branches from a few cells upon one side of the main strand.

Gloeosporium

- Fig. 97. G. rufomaculans (Berk.) Thum. An early stage of meristogenous development. This method rarely occurs.
- Fig. 98. Side view of an acervulus formed by the symphogenous method. It has been compressed so that the cushion-like bed of conidiophores is pulled away from the basal hypha.

Plate IV - con.

- Fig. 99. G. musarum C. & M. Top view of a partially developed acervulus. Development is symphogenous.

Colletotrichum

- Fig. 100. C. lagenarium (Pers.) E. & H. A very early stage in which the acervulus originates in a few short branches from a single hypha.
- Fig. 101. Numerous budding branches from a few cells of one hypha forming the beginning of an acervulus. This is the simple meristogenous mode.
- Fig. 102. An early stage in the development of an acervulus.
- Fig. 103. A primordium in which a few branches are involved.
- Fig. 104. Early stage in symphogenous development. Hyphal branches loop and interweave in this mode.
- Fig. 105. Same as fig. 104 twenty-four hours later.
- Fig. 106. Beginning stage of symphogenous development.
- Fig. 107. A later stage.

PLATE 4



Plate V.

Pestalozzia

- Fig. 108. P. palmarum Cke. a, A very early stage in the meristogenous development. A few cells divided and swelling.
b, A later stage.
- Figs. 109, 110. Pycnidia with young spores developed within.
- Fig. 111. A primordium of compound meristogenous origin.
- Fig. 112. Young pycnidium at a stage just prior to opening.
- Fig. 113. Pycnidium opening and extruding spores. Following this stage the cup-like interior is formed, longer conidio-phores develop and the body becomes a pseudo-acervulus.
- Figs. 114, 115. P. guepini Desm. Early stages in the symphogenous development.
- Fig. 116. A later stage. The pycnidia of this species form spores within and later break open as pseudo-acervuli.
- Fig. 117. Pestalozzia from peony. A meristogenously developed pycnidial mass.
- Fig. 118. An early stage in symphogenous development.
- Fig. 119. A later stage.
- Fig. 120. A pycnidium which has opened, surface view.
- Fig. 121. Pestalozzia from maple. Compound meristogenous development from a number of parallel hyphae.
- Fig. 122. A later stage.
- Fig. 123. A young pycnidium breaking open on one side. The spores show within.

PLATE 5

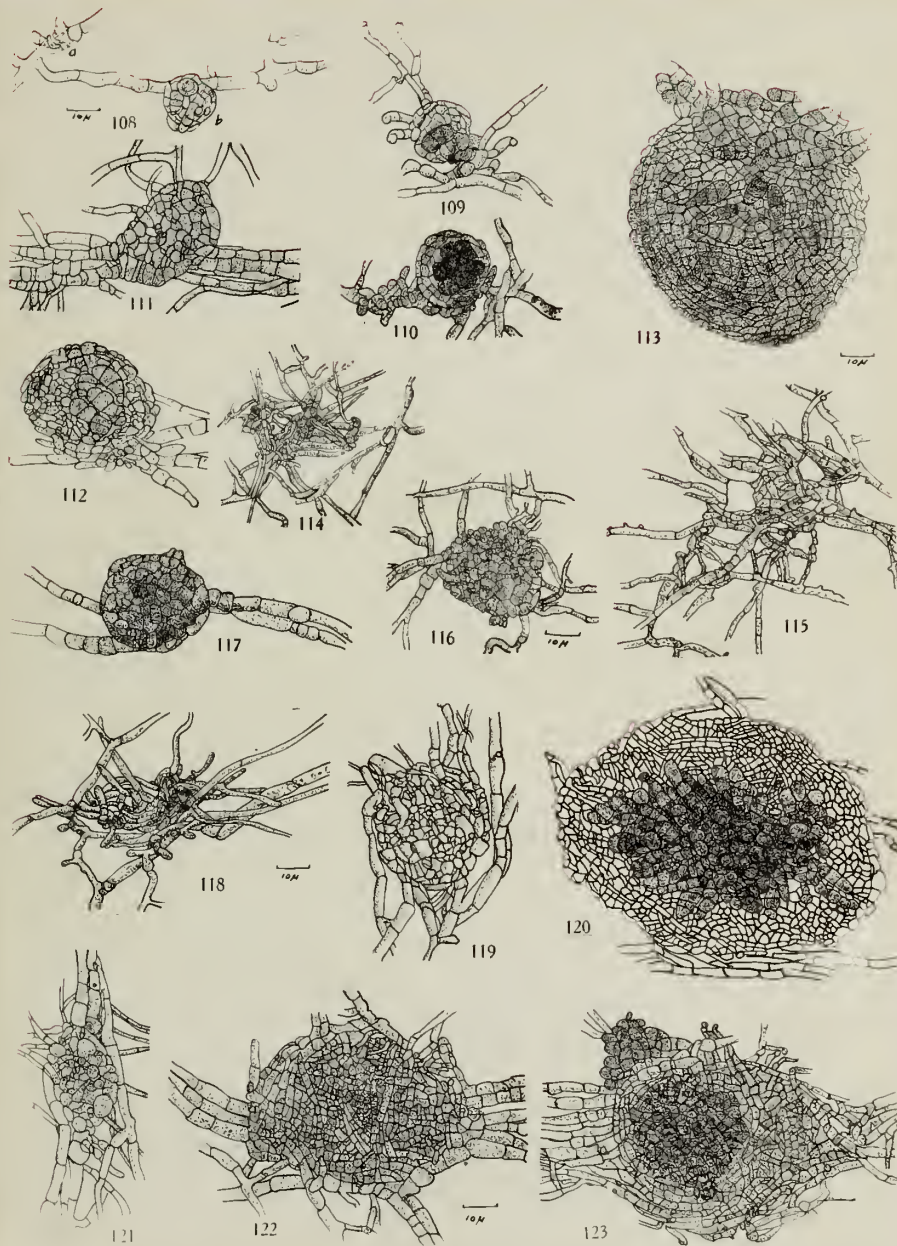


Plate VI.

Patellinia

- Fig. 124. P. fragariae S. & P. A single strand, with characteristic branching, from a sporogenous area.
- Fig. 125. A compound meristogenously developed sporodochium produced from a number of hyphae as fig. 124.
- Fig. 126. A simple meristogenous development with branches arising from a few cells.
- Fig. 127. A later stage in a simple meristogenous development.
- Fig. 128. A simple, meristogenously developed, mature sporodochium.
- Fig. 129. Pestalozzia from quince. Sporodochium of compound meristogenous development. The spore bearing area develops from a cup-like top.
- Fig. 130. Another view of a sporodochium similar to fig. 129.

Volutella

- Fig. 131. V. fructi S. & H. A very early stage in the simple meristogenous origin of a sporodochium. A few cells branch to form the base.
- Fig. 132. A slightly later stage.
- Fig. 133. A medium stage.
- Fig. 134. A fully developed base of subicle.
- Fig. 135. Same as fig. 131. Smaller hypha.
- Fig. 136. Later stage than fig. 135.
- Fig. 137. V. circinans Stevens & True. A simple meristogenous origin of a subicle in which a cell swells and branches by budding.
- Fig. 138. A hypha and branches. One branch has developed into a seta.
- Fig. 139. Beginning of a symphogenous development of a subicle.
- Fig. 140. A later stage.
- Fig. 141. Many branches interweaving to form a subicle.
- Fig. 142. A complex symphogenously developed subicle.

Plate VI - con.

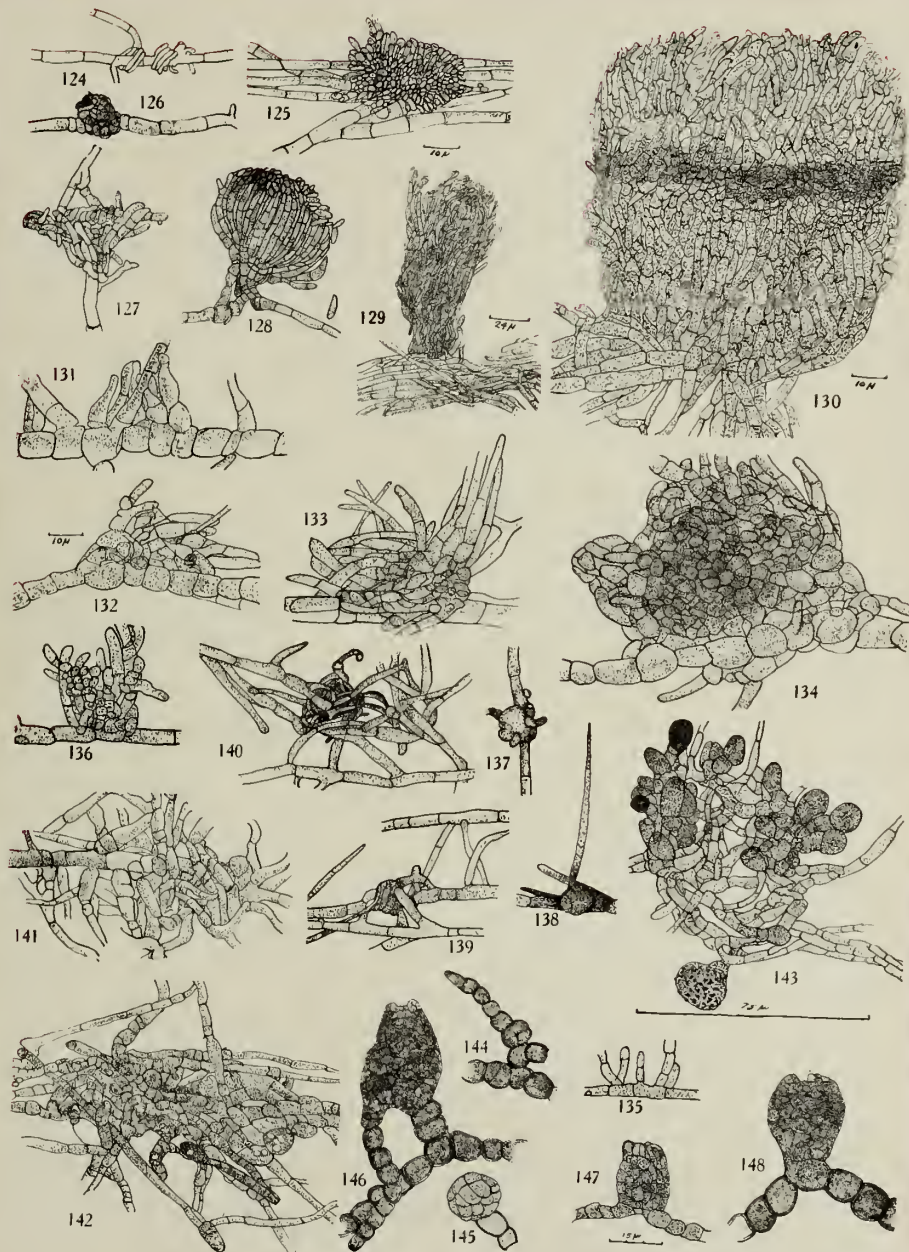
Epicoccum

- Fig. 143. Epicoccum species indet. Compound meristogenous development of a simple sporodochium with young spores.

Meliola (?)

- Fig. 144. Pycnidium with M. (?) camelliae. Four cell stage developed from a single cell within a hyphal branch.
- Fig. 145. A many-celled stage that appears to have developed from an end cell of a hypha.
- Fig. 146. Mature pycnidium that has developed from a single cell within the hypha.
- Fig. 147. Same as fig. 146.
- Fig. 148. A slightly different pycnidium from figs. 144 @ 146.

PLATE 6



Vita of author.

Forrest Ellwood Kempton was born near Centerville, Indiana, October 5, 1883; attended Centerville High School, graduating in 1902. Graduated from Earlham College, Richmond, Indiana, with the degree of Bachelor of Science in 1906; taught in schools of Wayne County, Indiana, 1906 to 1910; was farm manager and operator 1910-11, and taught in the public schools 1911-12. He entered the University of Wisconsin for graduate work in Botany and Plant Pathology in 1912, taking degree of Master of Science in Botany in June, 1913. He was acting Professor of Biology at Illinois College, Jacksonville, Illinois, 1913-1914. At the beginning of the University year 1914 he became an Assistant in Botany at the University of Illinois continuing graduate work. In February 1917 he accepted a position as Plant Pathologist in Smelter Smoke Investigation for the St. Louis Smelting & Refining Company at Collinsville, Illinois, and returned to the University of Illinois in September, 1918 as an assistant in Botany and graduate student.

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